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Patent Application

for

SYSTEM FOR PROVIDING WEB BROWSER ACCESS AND CONTROL OF DEVICES ON CUSTOMER PREMISES GATEWAY

by

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Cross Reference to Related Application:

Related subject matter is disclosed and claimed in co-pending U.S. Application Serial No. 09/137,074, filed by Smith et al. on August 20, 1998 which is incorporated herein by reference for all purposes.

Field of the Invention:

The invention relates to an embedded web server used in conjunction with a customer premises gateway to allow remote access and control via Markup Language (e.g., HTML or XML) pages of smart devices, appliances, personal computers, among

other devices and systems connected at a customer premises via different communication means and protocols.

Background of the Invention

A number of systems have been proposed for automated appliance control whereby communication with the controlled devices is confined within a customer premises (e.g., a residential or commercial building) and is implemented via a wireless network of radio frequency transmitter/receiver devices and repeaters, or via a signal carrying bus. Two such systems are disclosed in U.S. Patent Nos. 5,838,226 and 5,815,086.

Systems have also been proposed which allow automation of customer premises devices such as appliances, a lighting system, a home security system and an environment control device (i.e., heating, ventilation and air conditioning (HVAC)) from a remote location, as well as within the home or office. One such system is disclosed in U.S. Patent No. 5,086,385. The system comprises a central processor which is connected to the various devices and subsystems via a data bus. The system uses a high resolution graphics display and associated touch screen interface with other input devices such as a voice recognition system and telephone to allow the input of user commands. The system can be connected to an external network for operation from a remote location via an Ethernet link. Devices that use different protocols such as RS-232 can be connected to the system via a converter. A device can also be connected to the data bus through a converter to various home automation buses such as the CEBus, the Smart House standard bus, LONWORKS® or X10. U.S. Patent 5,880,677, on the other hand, discloses a system for monitoring electrical consumption by devices from a remote location using a laptop and telephone line connection to the customer premises. A control unit is provided on the customer premises to integrate a home computer, the internet and the devices to be controlled. A user screen can be provided to facilitate the switching of devices on and off.

The above described systems are disadvantageous in that they use an application specific interface provided by specialized software provided on the laptop or computer.

Thus, a user cannot gain access and control devices and appliances at a customer premises without a computer having the specific application software loaded thereon.

Summary of the Invention

The above-described disadvantages are overcome and a number of advantages are realized by a system which provides web browser access and control of smart devices, appliances and systems such as HVAC, lighting and security systems on the customer premises in accordance with the present invention.

In accordance with one aspect of the present invention, a gateway at the customer premises has a server and a software stack of application program interfaces (APIs) for each of a plurality of smart devices. The server maintains a Markup Language-type page having icons for the devices and, in response to navigation of the Markup Language-type page, generates device management messages.

In accordance with another aspect of the present invention, the devices at the customer premises are connected using different communication media and protocols. The gateway processes device management messages to determine an appropriate API to generate and transmit commands for devices using the correct protocol therefor.

In accordance with still yet another aspect of the present invention, an initial access Markup Language-type page is provided. Separate Markup Language-type pages for different devices are accessed by navigating the initial access page.

In accordance with another aspect of the present invention, Markup Language-type pages are provide with icons representing each of the different communication media used at a customer premises.

In accordance with another aspect of the present invention, the initial access page is generated by prompting a user to enter information relating to the types of devices to be controlled via web browsing and the types of communication media used.

Brief Description of Drawings:

The various aspects, advantages and novel features of the present invention will be more readily comprehended from the following detailed description when read in conjunction with the appended drawings, in which:

Fig. 1 depicts a customer premises gateway and devices connected thereto constructed in accordance with an embodiment of the present invention;

Fig. 2 depicts an exemplary customer premises gateway used with three different types of communication media in accordance with an embodiment of the present invention;

Fig. 3 is a block diagram of a premises gateway constructed in accordance with an embodiment of the present invention;

Fig. 4 illustrates an exemplary initial smart device access Markup Language-type page in accordance with an embodiment of the present invention; and

Fig. 5 is a flow chart depicting a number of operations for generating a smart device access Markup Language-type page in accordance with an embodiment of the present invention.

Throughout the drawing figures, like reference numerals will be understood to refer to like parts and components.

Detailed Description Of The Preferred Embodiments

With reference to Fig. 1, a customer premises gateway (CPG) 10 is depicted which comprises an embedded web server 12 and a backend software stack interface 14 in accordance with an embodiment of the present invention. The CPG 10 operates as a gateway for different types of communication links and protocols used at the customer premises to communicate with different devices. The CPG 10 allows the functionality of each device to be controllable by a user via one or more Markup Language (e.g., HTML or XML) pages designed to manage respective devices. The devices can be, but are not limited to, a personal computer (PC) 16, a smart refrigerator 18, a digital video or versatile disc (DVD) player 20, a home security system 22 and a lighting controller 24, as shown in Fig. 1.

Other devices can include a utility meter, a telephone or video telephone, automatically controlled drapes, and an HVAC control system, for example.

The devices are hereinafter referred to as smart devices since they are configured for remote operation and control by a local computer on the customer premises, or a by remote computer. The local or remote computer communicates with the devices via a telephone line, a power line or other communication link. The smart devices operate in conjunction with an application program interface (API) to support a signaling protocol for receiving and responding to commands from a control device such as a local computer and, for some devices, transmitting status information from the smart device to the control device.

As stated previously, the CPG 10 is connected to the smart devices via different communication media and protocols indicated generally at 26. The communication media 26 can be one or more of twisted pair, coaxial cable, a fiber optic link, a hybrid fiber optic/coaxial cable link, a wireless link (e.g., an infrared or radio frequency link) or signaling via an AC power line. The protocols can be the Ethernet, and the consumer electronic bus (CEBus®) standard and the Home Phone line Networking Alliance (HomePNA®) standard for power line-controllable smart devices and telephone line-controllable smart devices, respectively, among other protocols. For example, devices can communicate via other appliance automation standards such as Smart House®, LONWORKS®, D2B®, Medialink®, among others. It is to be understood that communication with the smart devices can be in accordance with a standard device automation bus and/or signaling protocol, or a custom application program interface (API) and link.

Exemplary communication media 26 are depicted in Fig. 2 which comprise an Ethernet Cat 5 link 34 or similar communication link between the home PC 16 and the CPG 10. A twisted pair (TP) link 36 connects a PC 38, a telephone 40 and a television 42 (e.g., a television connected to a TP link via a set-top box) to the CPG 10 using plain old telephone service (POTS), or HomePNA protocol using devices. The communication media 26 in Fig. 2 also include a signal-carrying power line 44 connected to an electric meter 46 and a water meter 48.

The communications link 32 in Fig. 1 illustrates the manner in which the CPG 10 communicates with remote entities such as servers and remote PCs with web browsers 28

via a digital communications network 30 such as the internet, an intranet or a service provider network. The communications link 32 can be configured using different transmission media such as twisted pair, coaxial cable, a fiber optic link, a hybrid fiber optic/coaxial cable link, and a wireless link. Accordingly, different communication technology can be employed for the communications link 32 such as a digital subscriber line (i.e., xDSL) and access modem (i.e., a DSLAM), broadcast satellite communications, CATV and cable modem, and so on. In the illustrated embodiment of Fig. 2, the CPG 10 is connected to the internet 30 via a POTS or ADSL line 50 and a DSLAM 52.

The CPG 10 can be implemented as one or more boards having interfaces to the different communication media 26 and 32 and a processing device programmed to control the routing operations between the network 30 and the devices via different communication media 26 and 32 and protocols. With reference to Fig. 3, the CPG 10 is configured to communicate with different host systems through the network 30 via different transmission media such as a hybrid fiber optic coaxial link, or a radio frequency (RF) link, among others, and different signal protocols. In addition, the CPG 10 communicates with network interface modules (NIMs) connected to respective smart devices.

With continued reference to Fig. 3, the CPG 10 has an external link NIM 62 to convert broadband signals into digital data that can be processed by a processing core 64. The processing core 64 has memory devices indicated at 66, a central processing unit (CPU) 68 and a bus arbiter 70 for the bus 72. The processing core 64 passes data to an internal NIM, depending on the type of data. Internal NIMs can be provided to a NIM 65 for an HomePNA (HPN), a NIM 67 for signaling via a power line (e.g., a ceBus), among other NIMs 69. The processing core 64 can also intercept data from the NIM 62 and use the data to control smart devices at the customer premises or ascertain their status.

The configuration of Markup Language-type pages to access smart devices will now be described with continued reference to Figs. 4 and 5. When a CPG 10 is installed at a customer premises, a CPG software program provided with the CPG 10 is loaded on the customer PC 16. The CPG software program provides an interface between the PC 16 and the CPG 10 to allow smart device information entered by the customer via the PC 16 to be sent to the CPG 10. When the CPG software program is running, the PC 16 generates user

prompts which require the user to enter information regarding the number of rooms on the customer premises, and the number and location of smart devices to be controlled via the CPG 10, as indicated at block 80 in Fig. 4. The CPG 10 can undergo a discovery procedure provided by a device management protocol such as SNMP whereby the smart devices are queried to determine the software version of their respective APIs and other information such as the types of communication links that are connected to the CPG 10 (e.g., Ethernet 34, CEBus 44 and HomePNA 36). This information can also be entered manually in response to user prompts generated by the PC 16.

In accordance with the CPG program software, the PC 16 generates an initial smart device access Markup Language (e.g., XML) page using the smart device information entered by the user or otherwise obtained, as indicated at block 82 in Fig. 4. The initial smart device access XML page resides in the embedded web server 12 of the CPG 10. The present invention is advantageous because the initial access XML page is accessible at any local or remote location from which the user can establish internet access using essentially any computer, lap top or hand-held computing device. In other words, the user is not limited to local or remote access to the smart devices via a particular computer on which a specific appliance automation program is installed.

To generate an initial smart device access XML page, the PC 16 creates a Markup Language page in accordance with the CPG program software which has an icon for each smart device that is to be controlled via the CPG 10. The icons are selected from a library of icons provided by the CPG program software. An exemplary initial smart device access XML page 98 is depicted in Fig. 5. The XML page 98 comprises an icon 100 representing each of a number of telephones, a home security system icon 102, security sensor icons 104, a water meter icon 106, a utility meter icon 108, a set top box icon 110, a smart refrigerator icon 112, a smart stereo system icon 114, a lawn sprinkler icon 116 including icons 118 for the different sprinkler heads, as well as graphic representations of the communication links (e.g., a HomePNA link, a CEBus network and a coaxial cable). The background of the XML page 98 can be generated to resemble the floor plan of the customer premises pursuant to user inputs using the CPG software program, or can be generated to resemble a

generic residential or business floor plan. The XML page 98 can also provide a list 120 of the devices.

With further reference to Fig. 4, the APIs for smart devices are typically provided by the smart device manufacturers. In accordance with the present invention, smart device XML pages are generated for each of a plurality of devices that can be supported by the CPG 10 using their respective APIs. When a user accesses the XML page 98 via the internet or local area network (LAN) 30, the user can click on one of the icons or an item in the ASCII list 120 to navigate to one of the smart device XML pages. Each smart device XML page provides an interface for the corresponding smart device based on its functions. Each smart device XML page provides icons to allow a user or service provider to set device parameters and to input commands for that device. For example, an XML page for a smart refrigerator can allow the user to set the operating temperature and to enter bar codes or other indicia relating to items stored in the refrigerator. The smart refrigerator can be programmed via its API to send a message to a grocer's on-line delivery request system via the CPG 10 and the internet 30 to automatically arrange for the delivery of an item when the refrigerator detects that the stock of an item has decreased below a selected level.

With reference to block 84 of Fig. 4, the CPG 10 obtains XML pages for each of the smart devices listed on the initial smart device access XML page 98. The smart device XML pages are maintained by the embedded web server 12 at the CPG 10. The embedded web server 12 can be provided with a number of smart device XML pages when the CPG 10 is initially installed. The provider of internet protocol (IP) traffic to the CPG 10 via the link 32 (e.g., a DSL or POTS line 50, an asynchronous transfer mode (ATM) link, or other wireless or wireline link) can be any service provider. Additional smart device XML pages, or updates for existing smart device XML pages is use at a CPG 10, can be obtained (e.g., downloaded via the internet) from any service provider 53 (Fig. 2), smart device manufacturer, or other source. As indicated by blocks 86 and 88, the CPG 10 is preferably programmed to periodically determine if additional APIs or updated APIs are needed, as well. Thus, the CPG 10 can be updated periodically to accommodate new smart devices or new controllable functions of smart devices.

In response to user inputs using the XML page for a particular smart device, the CPG 10 is programmed to access a selected API for that device. The API instructs the CPG 10 as to how to communicate with that particular smart device (e.g., the type of communication link, the selected protocol, the command and response set that is understood by the smart device, and so on). The application layer protocol for each smart device is implemented separately for each device as part of the software stack interface 14. The software stack interface translates device management traffic (e.g., data input via the XML page for the smart device) arriving at the customer premises in HyperText Transport Protocol (HTTP) over internet protocol (IP packets) or via a LAN into device management data for transmission over a selected one of the communication media 26 (e.g., HomePNA® or CEBus). The CPG 10 is programmed in accordance with a routing process to filter out HTTP over IP traffic from the network 30 and redirect each device management message therein to an appropriate API to process that particular message, as indicated at blocks 90 and 92. The APIs convert the device management message to an appropriate device command. The gateway 10 is subsequently initiates a home PNA data transfer process, a CEBus data transfer process or other process depending on the device interface standard used by the smart device to connect to the CPG 10 via the communication media 26. The APIs can also receive and process status signals and other signals generated by their corresponding devices. Thus, the CPG 10 is advantageous because it can multiplex high bandwidth data into the customer premises over a plurality of communication media 26. Accordingly, visibility of all device controlled via the CPG 10 is available from the same point (e.g., from a local or remote laptop or other computing device.

Smart device Markup Language-type pages can be provided with separate icons for devices such as security system sensors 104 and sprinkler heads 118 located at different places on the customer premises, as well as for other smart devices having several controllable components or sensors. These separate icons are advantageous because a user or service provider such as a home security company can access an XML page for the security system and determine from a remote location whether a particular motion of contact sensor on a window or door has been tripped, for example. In cases of false alarms,

the security system can be reset from a remote location. In addition, malfunctioning devices can be disabled or their parameters modified to make the devices less susceptible to false tripping. A service provider can also gain access to the XML page for a particular user's CPG 10 to push software updates to the customer premises. A user can also use the CPG 10 to turn off lights in particular rooms using a smart home light controller controllable by the CPG 10. A user can select one of a number of personal computers on the initial access XML page to gain direct access to a particular computer and to remotely transfer files or view or listen to multimedia files. The XML page can be used to inquire into utility usage and load control of different devices.

As stated previously, the CPG 10 of the present invention allows users to determine the status of the smart devices from a local or remote location using essentially any computer configured for internet or LAN access. The CPG 10 also allows service providers operating in conjunction with smart device manufacturers to perform functions requested by a user who owns the customer premises where the smart devices are installed. Access to the initial access XML page for the CPG 10 is preferably protected by user and password authentication using encryption prior to transfer via the internet.

Although the present invention has been described with reference to a preferred embodiment thereof, it will be understood that the invention is not limited to the details thereof. Various modifications and substitutions have been suggested in the foregoing description, and others will occur to those of ordinary skill in the art. All such substitutions are intended to be embraced within the scope of the invention as defined in the appended claims.